WRANGLER: Capture and De-Spin of Asteroids and Space Debris

Completed Technology Project (2014 - 2015)

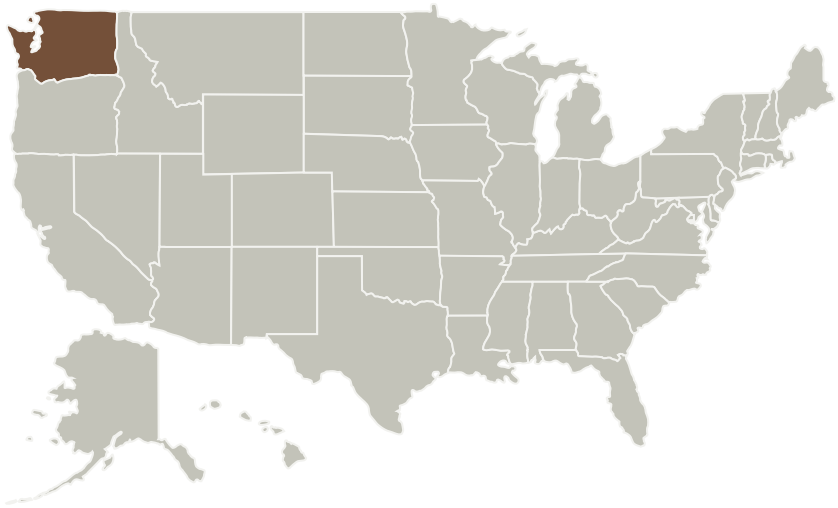
Project Introduction

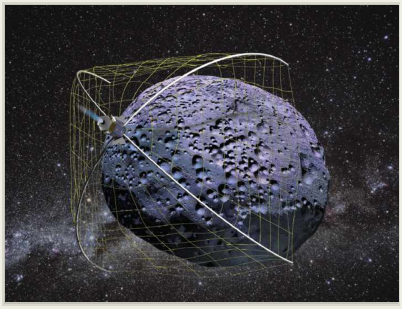
WRANGLER will accomplish these functions by combining two innovative technologies that have been developed by TUI: the GRASP deployable net capture device, and the SpinCASTER tether deployer/winch mechanism. Successful testing of both technologies in a microgravity environment has established these technology components at mid-TRL maturity. The leverage offered by using a tether to extract angular momentum from a rotating space object enables a very small nanosatellite system to de-spin a very massive asteroid or large spacecraft. The WRANGLER system is suitable for an incremental development program that will validate the technology through an affordable test flight in which a nanosatellite launched on a rideshare opportunity would capture and de-spin the upper state used to launch it.

Anticipated Benefits

The Phase I WRANGLER effort has demonstrated the feasibility and value of using a small tethered nanosatellite to accomplish capture and de-spin of space objects for future NASA and commercial efforts to acquire space resources from asteroids and actively remediate the space debris population. WRANGLER provides significant benefits to ARM, ADR and future commercial space resource development efforts by replacing hundreds or thousands of kilograms of propellant with a small, low-mass, low-cost system capable of enabling space systems to safely gain control of large space objects.

Primary U.S. Work Locations and Key Partners





Concept graphic of project

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Organizations Performing Work	Role	Type	Location
Tethers Unlimited Inc	Lead Organization	Industry	

Primary U.S. Work Locations
Washington

Project Transitions

July 2014: Project Start

March 2015: Closed out

Closeout Summary: The Phase I WRANGLER effort has demonstrated the feasibility and value of using a small tethered nanosatellite to accomplish capture and de-spin of space objects for future NASA and commercial efforts to acquire space resources from asteroids and actively remediate the space debris population. Current baseline architectures for capturing large space objects such as Near Earth Asteroids or spent rocket bodies rely upon a single high-value spacecraft to capture and reposition the target object as well as the use of thrusters to de-spin the object to allow maneuvering. Through detailed physics-based simulations we have demonstrated that tethered nanosatellites deployed from even the most massive fast rotators are effective at dramatically reducing the target's body rates and can be successfully controlled using simple control laws and high-TRL tether deployment hardware. We have developed two WRANGLER system concept designs capable of serving a variety of Asteroid Redirect Mission (ARM) and Active Debris Removal (ADR) CONOPS. The first is a small 2U picosatellite used simply as a means of de-spinning the target and the second is a larger free-flying nanosatellite used to both capture and de-spin the target object. Comparison of these concept designs to conventional propellant-based approaches has demonstrated the significant mass savings afforded by the WRANGLER concept. Furthermore, fractionation of the mission architectures by using a tethered nanosat for capture and de-spin can signficantly reduce the risks and requirements imposed on large primary mission spacecraft. The technologies required to provide the benefits of the WRANGLER system are all hardware of mid- to high-TRL. TUI's evaluation of the technology readiness of the concept indicates that a WRANGLER system that has the potential to provide order-ofmagnitude performance improvements can be designed and integrated with minimal effort and modest investment. While the remaining risks of the WRANGLER system are non-trivial, they are well understood and have clear and proven mitigation strategies that can be implemented with the proper engineering effort. WRANGLER provides significant benefits to ARM, ADR and future commercial space resource development efforts by replacing hundreds or thousands of kilograms of propellant with a small, low-mass, low-cost system capable of enabling space systems to safely gain control of large space objects.

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Tethers Unlimited Inc

Responsible Program:
NASA Innovative Advanced Concepts

Project Management

Program Director:
Jason E Derleth

Program Manager:
Eric A Eberly

Principal Investigator:
Robert Hoyt

Co-Investigator:
Jeffrey Slostad

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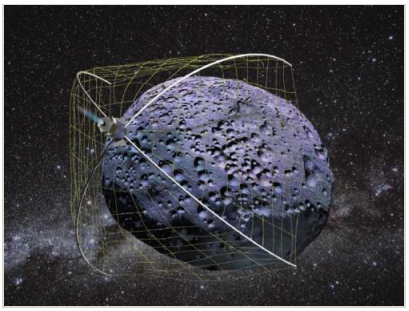
Images



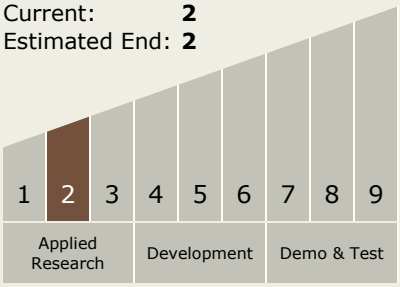
WRANGLER
Concept graphic of project
(https://techport.nasa.gov/image/102231)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.5 Autonomous Rendezvous and Docking
    - TX04.5.5 Capture Mechanisms and Fixtures

Target Destinations

Earth, Others Inside the Solar System